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Observing Resonant Entanglement Dynamics in Circuit QED J.A. MLYNEK, A.A. ABDUMALIKOV, J.M. FINK, L. STEFFEN, C. LANG, A.F. VAN LOO, A. WALLRAFF, ETH Zurich — We study the resonant interaction of up to three two-level systems and a single mode of an electromagnetic field in a circuit QED setup. Our investigation is focused on how a single excitation is dynamically shared in this fourpartite system. The underlying theory of the experiment is governed by the Tavis-Cummings-model, which on resonance predicts dynamics known as vacuum Rabi oscillations. The resonant situation has already been studied spectroscopically with three qubits [1] and time resolved measurements have been carried out in a tripartite system [2]. Here we are able to observe the coherent oscillations and their $\sqrt{N}$- enhancement by tracking the populations of all three qubits and the resonator. Full quantum state tomography is used to verify that the dynamics generates the maximally entangled 3-qubit W-state when the cavity state factorizes. The $\sqrt{N}$-speed-up offers the possibility to create W-states within a few ns with a fidelity of 75%. We compare the resonant collective method to an approach, which achieves entanglement by sequentially tuning qubits into resonance with the cavity.

[1] J. M. Fink, Physical Review Letters **103**, 083601 (2009)
[2] F. Altomare, Nature Physics **6**, 777–781 (2010)

- [x] Prefer Oral Session
- [ ] Prefer Poster Session

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